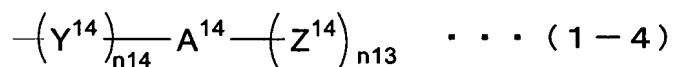


What is claimed is:

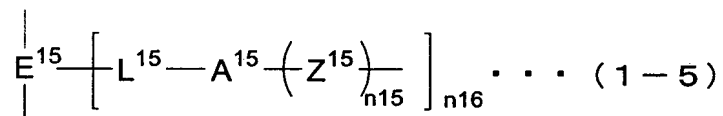
1. An organic-inorganic hybrid material produced by crosslinking a precursor that is an organosilicon compound having a mesogen group.

5        2. The organic-inorganic hybrid material of claim 1, which is produced by three-dimensionally crosslinking the precursor.

3. The organic-inorganic hybrid material of claim 1, further comprising at least one compound of the following  
10 formulae (1-4) and (1-5), wherein the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:



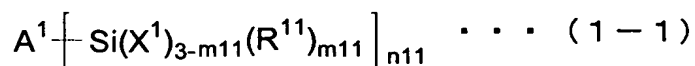
15



wherein, in formulae (1-4) and (1-5),  $\text{A}^{14}$  and  $\text{A}^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $\text{Z}^{14}$  and  $\text{Z}^{15}$  each represent a substituent not changing in sol-gel reaction, or a hydrogen atom;  $n13$  and  $n15$  each indicate an integer of from 1 to 8;  $n14$  indicates an integer of from 0 to 4;  $n16$  indicate an integer of from 1 to 5;  $\text{Y}^{14}$  represents a polymerizing group that may  
20 form a carbon-carbon bond or a carbon-oxygen bond through polymerization;  $\text{L}^{15}$  represents a linking group;  $\text{E}^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when  $n13$  or  $n15$  is 2 or more, then  $\text{Z}^{14}$ 's or  $\text{Z}^{15}$ 's may be the same or different.

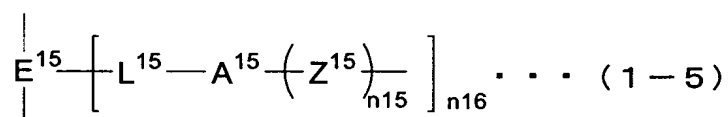
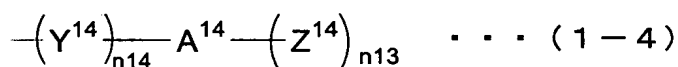
30        4. The organic-inorganic hybrid material of claim 1, which is produced by polymerizing a compound of the following

formula (1-1):



wherein  $A^1$  represents an organic atomic group that contains a mesogen group and an alkylene group having at least 4 carbon atoms;  $R^{11}$  represents an alkyl group, an aryl group or a heterocyclic group;  $X^1$  represents a halogen atom or  $OR^{14}$ ;  $R^{14}$  represents a hydrogen atom, an alkyl group, an aryl group or a silyl group;  $m11$  indicates an integer of from 0 to 2;  $n11$  indicates an integer of from 1 to 10; when  $m11$  or  $3-m11$  is 2 or more, then  $R^{11}$ 's or  $X^1$ 's may be the same or different.

5. The organic-inorganic hybrid material of claim 4, further comprising at least one compound of the following formulae (1-4) and (1-5), wherein the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:

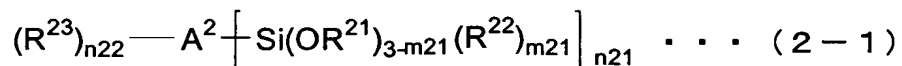


wherein in formulae (1-4) and (1-5),  $A^{14}$  and  $A^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $Z^{14}$  and  $Z^{15}$  each represent a substituent not changing in sol-gel reaction, or a hydrogen atom;  $n13$  and  $n15$  each indicate an integer of from 1 to 8;  $n14$  indicates an integer of from 0 to 4;  $n16$  indicate an integer of from 1 to 5;  $Y^{14}$  represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through polymerization;  $L^{15}$  represents a linking group;  $E^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group;

when n13 or n15 is 2 or more, then Z<sup>14</sup>'s or Z<sup>15</sup>'s may be the same or different.

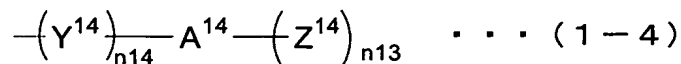
6. The organic-inorganic hybrid material of claim 1, which is produced by three-dimensionally crosslinking a precursor that is an organosilicon compound that has an alkoxy-silyl group, a mesogen group and a substituent group capable of forming a carbon-carbon bond or a carbon-oxygen bond through polymerization.

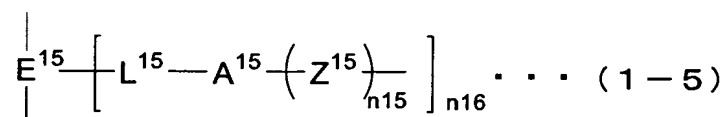
7. The organic-inorganic hybrid material of claim 6, which is produced through sol-gel reaction of a precursor that is an organosilicon compound of the following formula (2-1) to form an Si-O-Si bond, combined with polymerization of the substituent in the organosilicon compound to form a carbon-carbon bond or a carbon-oxygen bond:



wherein A<sup>2</sup> represents an organic atomic group containing a mesogen group; R<sup>21</sup> represents an alkyl group; R<sup>22</sup> represents an alkyl group, an aryl group or a heterocyclic group; R<sup>23</sup> represents a substituent group capable of forming a carbon-carbon bond or a carbon-oxygen bond through polymerization; m21 indicates an integer of from 0 to 2; n21 indicates an integer of from 1 to 10; n22 indicates an integer of from 1 to 5; when 3-m21 or m21 is 2 or more, then R<sup>21</sup>'s or R<sup>22</sup>'s may be the same or different; when n22 is 2 or more, then R<sup>23</sup>'s may be the same or different.

8. The organic-inorganic hybrid material of claim 7, further comprising at least one compound of the following formulae (1-4) and (1-5), wherein the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:

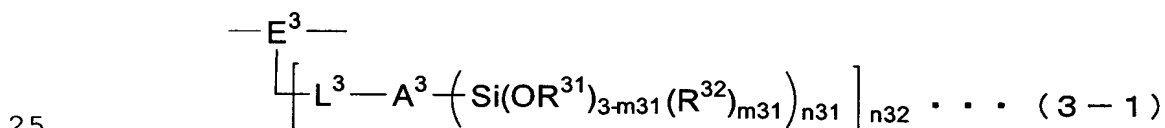




wherein, in formulae (1-4) and (1-5),  $\text{A}^{14}$  and  $\text{A}^{15}$  each represent  
 5 an organic atomic group that contains a mesogen and an alkylene  
 group having at least 4 carbon atoms;  $\text{Z}^{14}$  and  $\text{Z}^{15}$  each represent  
 a substituent not changing in sol-gel reaction, or a hydrogen  
 atom;  $n13$  and  $n15$  each indicate an integer of from 1 to 8;  
 $n14$  indicates an integer of from 0 to 4;  $n16$  indicate an integer  
 10 of from 1 to 5;  $\text{Y}^{14}$  represents a polymerizing group that may  
 form a carbon-carbon bond or a carbon-oxygen bond through  
 polymerization;  $\text{L}^{15}$  represents a linking group;  $\text{E}^{15}$  represents  
 an alkyleneoxy group, an alkylene group or a siloxy group;  
 when  $n13$  or  $n15$  is 2 or more, then  $\text{Z}^{14}$ 's or  $\text{Z}^{15}$ 's may be the  
 15 same or different.

9. The organic-inorganic hybrid material of claim 1,  
 which is produced through crosslinking polymerization of a  
 precursor that is a polymer having, in the side branches thereof,  
 an atomic group that contains an alkoxysilyl group, a mesogen  
 20 group and an alkylene group.

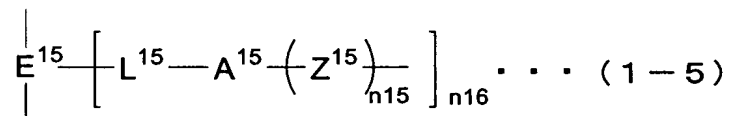
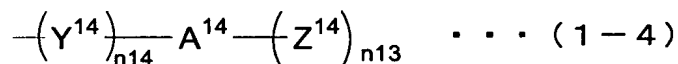
10. The organic-inorganic hybrid material of claim 9,  
 in which the precursor is a polymer having a repeating unit  
 of the following formula (3-1):



wherein  $\text{A}^3$  represents an organic atomic group that contains  
 a mesogen group and an alkylene group;  $\text{R}^{31}$  represents an alkyl  
 group;  $\text{R}^{32}$  represents an alkyl group, an aryl group or a  
 30 heterocyclic group;  $\text{E}^3$  represents an alkyleneoxy group, an

alkylene group or a siloxy group;  $L^3$  represents a linking group;  $m_{31}$  indicates an integer of from 0 to 2;  $n_{31}$  indicates an integer of from 1 to 10;  $n_{32}$  indicates an integer of from 1 to 5; when  $3-m_{31}$  or  $m_{31}$  is 2 or more, then  $R^{31}$ 's or  $R^{32}$ 's may be the same or different.

11. The organic-inorganic hybrid material of claim 10, further comprising at least one compound of the following formulae (1-4) and (1-5), wherein the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:



wherein, in formulae (1-4) and (1-5),  $A^{14}$  and  $A^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $Z^{14}$  and  $Z^{15}$  each represent a substituent not changing in sol-gel reaction, or a hydrogen atom;  $n_{13}$  and  $n_{15}$  each indicate an integer of from 1 to 8;  $n_{14}$  indicates an integer of from 0 to 4;  $n_{16}$  indicate an integer of from 1 to 5;  $Y^{14}$  represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through polymerization;  $L^{15}$  represents a linking group;  $E^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when  $n_{13}$  or  $n_{15}$  is 2 or more, then  $Z^{14}$ 's or  $Z^{15}$ 's may be the same or different.

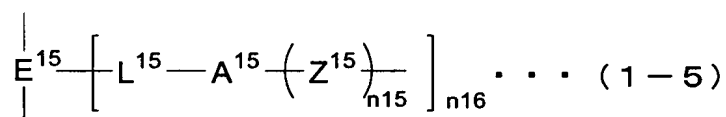
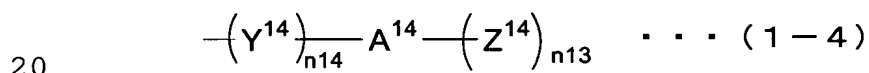
12. An organic-inorganic hybrid proton-conductive material containing a organic-inorganic hybrid material and a proton source which imparts proton conductivity into the organic-inorganic hybrid material, and wherein the

organic-inorganic hybrid material is produced by crosslinking a precursor that is an organosilicon compound having a mesogen group.

13. The organic-inorganic hybrid proton-conductive material of claim 12, wherein the organic-inorganic hybrid material is produced by three-dimensionally crosslinking the precursor.

14. The organic-inorganic hybrid proton-conductive material of claim 12, wherein the proton source is at least one selected from the group consisting of phosphorus compounds, organic sulfonic acids and perfluorocarbonsulfonic acid polymers.

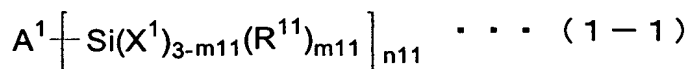
15. The organic-inorganic hybrid proton-conductive material of claim 12, the organic-inorganic hybrid material further comprises at least one compound of the following formulae (1-4) and (1-5), and wherein the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:



wherein, in formulae (1-4) and (1-5), A<sup>14</sup> and A<sup>15</sup> each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms; Z<sup>14</sup> and Z<sup>15</sup> each represent a substituent not changing in sol-gel reaction, or a hydrogen atom; n13 and n15 each indicate an integer of from 1 to 8; n14 indicates an integer of from 0 to 4; n16 indicate an integer of from 1 to 5; Y<sup>14</sup> represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through

polymerization;  $L^{15}$  represents a linking group;  $E^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when  $n_{13}$  or  $n_{15}$  is 2 or more, then  $Z^{14}$ 's or  $Z^{15}$ 's may be the same or different.

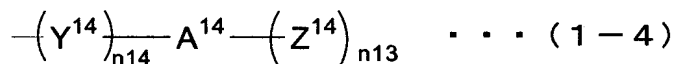
5            16. The organic-inorganic hybrid proton-conductive material of claim 12, the organic-inorganic hybrid material is produced by polymerizing a compound of the following formula (1-1):



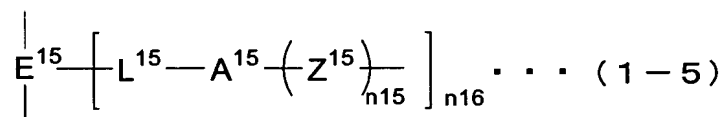
10        wherein  $A^1$  represents an organic atomic group that contains a mesogen group and an alkylene group having at least 4 carbon atoms;  $R^{11}$  represents an alkyl group, an aryl group or a heterocyclic group;  $X^1$  represents a halogen atom or  $OR^{14}$ ;  $R^{14}$  represents a hydrogen atom, an alkyl group, an aryl group or  
15        a silyl group;  $m_{11}$  indicates an integer of from 0 to 2;  $n_{11}$  indicates an integer of from 1 to 10; when  $m_{11}$  or  $3-m_{11}$  is 2 or more, then  $R^{11}$ 's or  $X^1$ 's may be the same or different.

          17. The organic-inorganic hybrid proton-conductive material of claim 16, wherein the proton source is at least  
20        one selected from the group consisting of phosphorus compounds, organic sulfonic acids and perfluorocarbonsulfonic acid polymers.

          18. The organic-inorganic hybrid proton-conductive material of claim 16, wherein the organic-inorganic hybrid  
25        material further comprises at least one compound of the following formulae (1-4) and (1-5), and wherein the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:



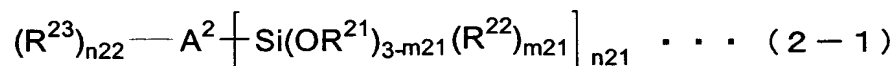
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wherein, in formulae (1-4) and (1-5),  $A^{14}$  and  $A^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $Z^{14}$  and  $Z^{15}$  each represent a substituent not changing in sol-gel reaction, or a hydrogen atom;  $n13$  and  $n15$  each indicate an integer of from 1 to 8;  $n14$  indicates an integer of from 0 to 4;  $n16$  indicate an integer of from 1 to 5;  $Y^{14}$  represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through polymerization;  $L^{15}$  represents a linking group;  $E^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when  $n13$  or  $n15$  is 2 or more, then  $Z^{14}$ 's or  $Z^{15}$ 's may be the same or different.

19. The organic-inorganic hybrid proton-conductive material of claim 11, wherein the organic-inorganic hybrid material is produced by three-dimensionally crosslinking a precursor that is an organosilicon compound that has an alkoxysilyl group, a mesogen group and a substituent group capable of forming a carbon-carbon bond or a carbon-oxygen bond through polymerization.

20. The organic-inorganic hybrid proton-conductive material of claim 19, wherein the organic-inorganic hybrid material is produced through sol-gel reaction of a precursor that is an organosilicon compound of the following formula (2-1) to form an Si-O-Si bond, combined with polymerization of the substituent in the organosilicon compound to form a carbon-carbon bond or a carbon-oxygen bond:



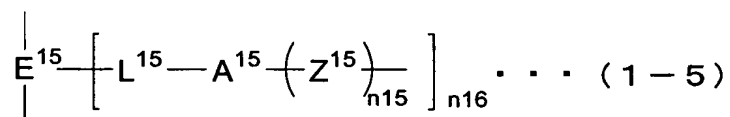
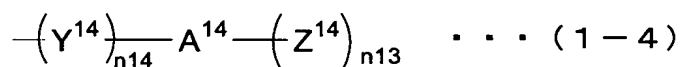
wherein  $A^2$  represents an organic atomic group containing a mesogen group;  $R^{21}$  represents an alkyl group;  $R^{22}$  represents



an alkyl group, an aryl group or a heterocyclic group;  $R^{23}$  represents a substituent group capable of forming a carbon-carbon bond or a carbon-oxygen bond through polymerization; m21 indicates an integer of from 0 to 2; n21 indicates an integer of from 1 to 10; n22 indicates an integer of from 1 to 5; when 3-m21 or m21 is 2 or more, then  $R^{21}$ 's or  $R^{22}$ 's may be the same or different; when n22 is 2 or more, then  $R^{23}$ 's may be the same or different.

21. The organic-inorganic hybrid proton-conductive material of claim 20, wherein the proton source is at least one selected from the group consisting of phosphorus compounds, organic sulfonic acids and perfluorocarbonsulfonic acid polymers.

22. The organic-inorganic hybrid proton-conductive material of claim 20, wherein the organic-inorganic hybrid material further comprises at least one compound of the following formulae (1-4) and (1-5), and wherein the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:

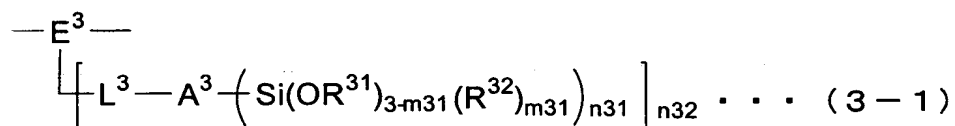


wherein, in formulae (1-4) and (1-5),  $A^{14}$  and  $A^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $Z^{14}$  and  $Z^{15}$  each represent a substituent not changing in sol-gel reaction, or a hydrogen atom; n13 and n15 each indicate an integer of from 1 to 8; n14 indicates an integer of from 0 to 4; n16 indicate an integer of from 1 to 5;  $Y^{14}$  represents a polymerizing group that may

form a carbon-carbon bond or a carbon-oxygen bond through polymerization;  $L^{15}$  represents a linking group;  $E^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when  $n_{13}$  or  $n_{15}$  is 2 or more, then  $Z^{14}$ 's or  $Z^{15}$ 's may be the same or different.

23. The organic-inorganic hybrid proton-conductive material of claim 12, wherein the organic-inorganic hybrid material is produced through crosslinking polymerization of a precursor that is a polymer having, in the side branches thereof, an atomic group that contains an alkoxysilyl group, a mesogen group and an alkylene group.

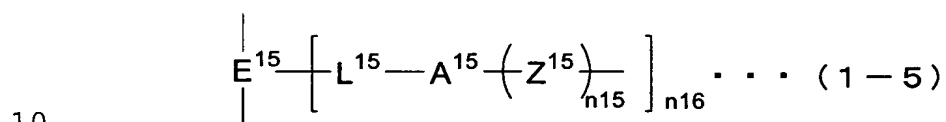
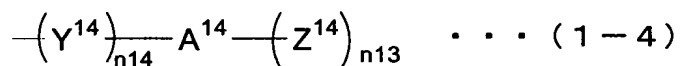
24. The organic-inorganic hybrid proton-conductive material of claim 23, wherein the organic-inorganic hybrid material is produced by a precursor is a polymer having a repeating unit of the following formula (3-1):



wherein  $A^3$  represents an organic atomic group that contains a mesogen group and an alkylene group;  $R^{31}$  represents an alkyl group;  $R^{32}$  represents an alkyl group, an aryl group or a heterocyclic group;  $E^3$  represents an alkyleneoxy group, an alkylene group or a siloxy group;  $L^3$  represents a linking group;  $m_{31}$  indicates an integer of from 0 to 2;  $n_{31}$  indicates an integer of from 1 to 10;  $n_{32}$  indicates an integer of from 1 to 5; when  $3-m_{31}$  or  $m_{31}$  is 2 or more, then  $R^{31}$ 's or  $R^{32}$ 's may be the same or different.

25. The organic-inorganic hybrid proton-conductive material of claim 24, wherein the proton source is at least one selected from the group consisting of phosphorus compounds, organic sulfonic acids and perfluorocarbonsulfonic acid polymers.

26. The organic-inorganic hybrid proton-conductive material of claim 24, wherein the organic-inorganic hybrid material further comprises at least one compound of the following formulae (1-4) and (1-5), and wherein the amount  
 5 of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:



wherein, in formulae (1-4) and (1-5),  $A^{14}$  and  $A^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $Z^{14}$  and  $Z^{15}$  each represent  
 15 a substituent not changing in sol-gel reaction, or a hydrogen atom;  $n13$  and  $n15$  each indicate an integer of from 1 to 8;  $n14$  indicates an integer of from 0 to 4;  $n16$  indicate an integer of from 1 to 5;  $Y^{14}$  represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through  
 20 polymerization;  $L^{15}$  represents a linking group;  $E^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when  $n13$  or  $n15$  is 2 or more, then  $Z^{14}$ 's or  $Z^{15}$ 's may be the same or different.

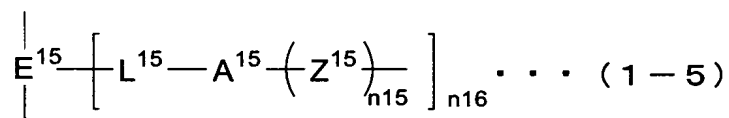
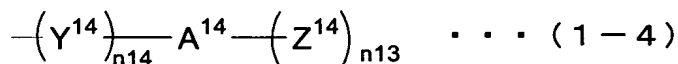
27. A fuel cell that comprises an organic-inorganic  
 25 hybrid proton-conductive material, wherein the organic-inorganic hybrid proton-conductive material containing a organic-inorganic hybrid material and a proton source which imparts proton conductivity into the organic-inorganic hybrid material, and wherein the  
 30 organic-inorganic hybrid material is produced by crosslinking a precursor that is an organosilicon compound having a mesogen

group.

28. The fuel cell of claim 27, wherein the organic-inorganic hybrid material is produced by three-dimensionally crosslinking the precursor.

29. The organic-inorganic hybrid proton-conductive material of claim 27, wherein the proton source is at least one selected from the group consisting of phosphorus compounds, organic sulfonic acids and perfluorocarbonsulfonic acid polymers.

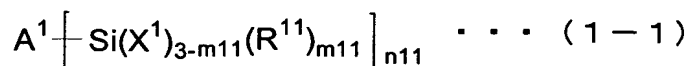
30. The organic-inorganic hybrid proton-conductive material of claim 27, wherein the organic-inorganic hybrid material further comprises at least one compound of the following formulae (1-4) and (1-5), and the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:



wherein, in formulae (1-4) and (1-5),  $\text{A}^{14}$  and  $\text{A}^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $\text{Z}^{14}$  and  $\text{Z}^{15}$  each represent a substituent not changing in sol-gel reaction, or a hydrogen atom;  $n13$  and  $n15$  each indicate an integer of from 1 to 8;  $n14$  indicates an integer of from 0 to 4;  $n16$  indicate an integer of from 1 to 5;  $\text{Y}^{14}$  represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through polymerization;  $\text{L}^{15}$  represents a linking group;  $\text{E}^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when  $n13$  or  $n15$  is 2 or more, then  $\text{Z}^{14}$ 's or  $\text{Z}^{15}$ 's may be the

same or different.

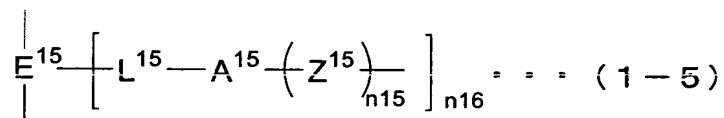
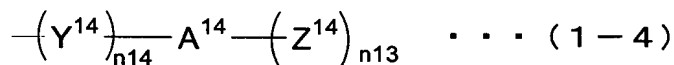
31. The organic-inorganic hybrid proton-conductive material of claim 27, wherein the organic-inorganic hybrid material is produced by polymerizing a compound of the following formula (1-1):



wherein  $A^1$  represents an organic atomic group that contains a mesogen group and an alkylene group having at least 4 carbon atoms;  $R^{11}$  represents an alkyl group, an aryl group or a heterocyclic group;  $X^1$  represents a halogen atom or  $OR^{14}$ ;  $R^{14}$  represents a hydrogen atom, an alkyl group, an aryl group or a silyl group; m11 indicates an integer of from 0 to 2; n11 indicates an integer of from 1 to 10; when m11 or 3-m11 is 2 or more, then  $R^{11}$ 's or  $X^1$ 's may be the same or different.

32. The organic-inorganic hybrid proton-conductive material of claim 31, wherein the proton source is at least one selected from the group consisting of phosphorus compounds, organic sulfonic acids and perfluorocarbonsulfonic acid polymers.

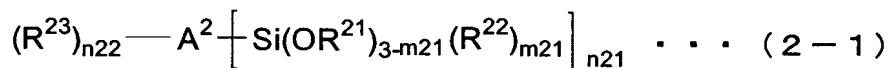
33. The organic-inorganic hybrid proton-conductive material of claim 31, wherein the organic-inorganic hybrid material further comprises at least one compound of the following formulae (1-4) and (1-5), and wherein the amount of the at least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:



wherein, in formulae (1-4) and (1-5),  $A^{14}$  and  $A^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $Z^{14}$  and  $Z^{15}$  each represent a substituent not changing in sol-gel reaction, or a hydrogen atom; n13 and n15 each indicate an integer of from 1 to 8; n14 indicates an integer of from 0 to 4; n16 indicate an integer of from 1 to 5;  $Y^{14}$  represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through polymerization;  $L^{15}$  represents a linking group;  $E^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when n13 or n15 is 2 or more, then  $Z^{14}$ 's or  $Z^{15}$ 's may be the same or different.

34. The organic-inorganic hybrid proton-conductive material of claim 27, wherein the organic-inorganic hybrid material is produced by three-dimensionally crosslinking a precursor that is an organosilicon compound that has an alkoxysilyl group, a mesogen group and a substituent group capable of forming a carbon-carbon bond or a carbon-oxygen bond through polymerization.

35. The organic-inorganic hybrid proton-conductive material of claim 34, wherein the organic-inorganic hybrid material is produced through sol-gel reaction of a precursor that is an organosilicon compound of the following formula (2-1) to form an Si-O-Si bond, combined with polymerization of the substituent in the organosilicon compound to form a carbon-carbon bond or a carbon-oxygen bond:

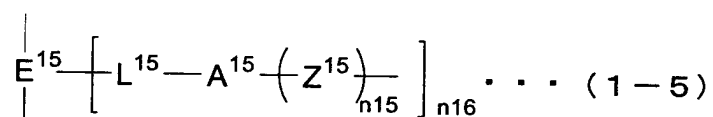
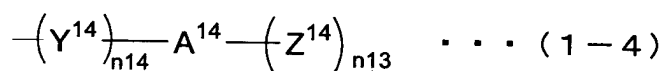


wherein  $A^2$  represents an organic atomic group containing a mesogen group;  $R^{21}$  represents an alkyl group;  $R^{22}$  represents an alkyl group, an aryl group or a heterocyclic group;  $R^{23}$  represents a substituent group capable of forming a carbon-carbon bond or a carbon-oxygen bond through polymerization; m21 indicates an integer of from 0 to 2; n21

indicates an integer of from 1 to 10; n22 indicates an integer of from 1 to 5; when 3-m21 or m21 is 2 or more, then R<sup>21</sup>'s or R<sup>22</sup>'s may be the same or different; when n22 is 2 or more, then R<sup>23</sup>'s may be the same or different.

5           36. The organic-inorganic hybrid proton-conductive material of claim 35, wherein the proton source is at least one selected from the group consisting of phosphorus compounds, organic sulfonic acids and perfluorocarbonsulfonic acid polymers.

10           37. The organic-inorganic hybrid proton-conductive material of claim 35, wherein the organic-inorganic hybrid material further comprises at least one compound of the following formulae (1-4) and (1-5), and wherein the amount of the at least one compound is in range of from 1 mol% to  
15 50 mol% relative to the precursor:



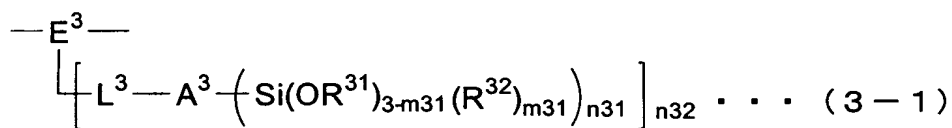
20

wherein, in formulae (1-4) and (1-5), A<sup>14</sup> and A<sup>15</sup> each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms; Z<sup>14</sup> and Z<sup>15</sup> each represent a substituent not changing in sol-gel reaction, or a hydrogen  
25 atom; n13 and n15 each indicate an integer of from 1 to 8; n14 indicates an integer of from 0 to 4; n16 indicate an integer of from 1 to 5; Y<sup>14</sup> represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through polymerization; L<sup>15</sup> represents a linking group; E<sup>15</sup> represents  
30 an alkyleneoxy group, an alkylene group or a siloxy group; when n13 or n15 is 2 or more, then Z<sup>14</sup>'s or Z<sup>15</sup>'s may be the

same or different.

38. The organic-inorganic hybrid proton-conductive material of claim 27, wherein the organic-inorganic hybrid material is produced through crosslinking polymerization of a precursor that is a polymer having, in the side branches thereof, an atomic group that contains an alkoxysilyl group, a mesogen group and an alkylene group.

39. The organic-inorganic hybrid proton-conductive material of claim 38, wherein the organic-inorganic hybrid material is produced by a precursor is a polymer having a repeating unit of the following formula (3-1):



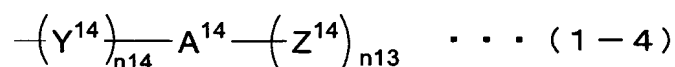
wherein A<sup>3</sup> represents an organic atomic group that contains a mesogen group and an alkylene group; R<sup>31</sup> represents an alkyl group; R<sup>32</sup> represents an alkyl group, an aryl group or a heterocyclic group; E<sup>3</sup> represents an alkyleneoxy group, an alkylene group or a siloxy group; L<sup>3</sup> represents a linking group; m31 indicates an integer of from 0 to 2; n31 indicates an integer of from 1 to 10; n32 indicates an integer of from 1 to 5; when 3-m31 or m31 is 2 or more, then R<sup>31</sup>'s or R<sup>32</sup>'s may be the same or different.

40. The organic-inorganic hybrid proton-conductive material of claim 39, wherein the proton source is at least one selected from the group consisting of phosphorus compounds, organic sulfonic acids and perfluorocarbonsulfonic acid polymers.

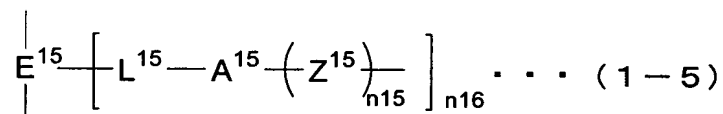
41. The organic-inorganic hybrid proton-conductive material of claim 39, wherein the organic-inorganic hybrid material further comprises at least one compound of the following formula (1-4) and (1-5), and the amount of the at



least one compound is in range of from 1 mol% to 50 mol% relative to the precursor:



5



wherein in formulae (1-4) and (1-5),  $A^{14}$  and  $A^{15}$  each represent an organic atomic group that contains a mesogen and an alkylene group having at least 4 carbon atoms;  $Z^{14}$  and  $Z^{15}$  each represent a substituent not changing in sol-gel reaction, or a hydrogen atom;  $n13$  and  $n15$  each indicate an integer of from 1 to 8;  $n14$  indicates an integer of from 0 to 4;  $n16$  indicate an integer of from 1 to 5;  $Y^{14}$  represents a polymerizing group that may form a carbon-carbon bond or a carbon-oxygen bond through polymerization;  $L^{15}$  represents a linking group;  $E^{15}$  represents an alkyleneoxy group, an alkylene group or a siloxy group; when  $n13$  or  $n15$  is 2 or more, then  $Z^{14}$ 's or  $Z^{15}$ 's may be the same or different.